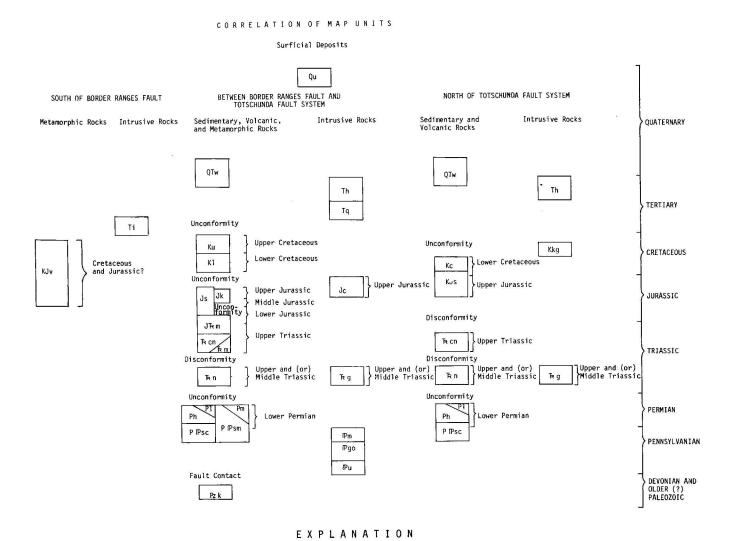
GEOLOGIC MAP OF THE McCARTHY QUADRANGLE, ALASKA

1976

BACKGROUND INFORMATION FOR THIS MAP IS PUBLISHED AS U. S. GEOLOGICAL SURVEY CIRCULAR 739, AVAILABLE FREE OF CHARGE FROM THE U. S. GEOLOGICAL SURVEY, RESTON, VA 22092 E. M. MACKEVETT, JR.



Contact, showing dip; dotted where concealed Overturned contact, showing dip; dotted where concealed

High-angle fault, showing dip of fault plane. Dashed where approximate; queried where doubtful; dotted where concealed. U, upthrown side; D, downthrown side Thrust fault, showing dip of fault plane. Dashed where approximate; dotted where concealed. Saw teeth Syncline, approximately located, showing trace of axial surface Anticline. approximately located, showing trace of axial surface

Overturned anticline Strike and dip of beds Strike and dip of overturned beds

> Horizontal beds Strike and dip of lava flows Strike and dip of foliation Strike of vertical foliation

Note: Mines, prospects, and main mineral occurrences are shown and briefly described on a separate map of this folio (MF 773-B).

DESCRIPTION OF MAP UNITS SURFICIAL DEPOSITS

Diverse Quaternary surficial deposits are abundant in the quadrangle. Quaternary processes of deposition and erosion strongly influenced the landscape, producing many of the scenic and physiographic features. Some surficial deposits are exceptionally well developed. Surficial deposits, only cursorily studied during our investigations, afford an excellent basis for potentially important future studies

UNDIFFERENTIATED SURFICIAL DEPOSITS--Includes alluvium, older alluvium, colluvium, talus, landslides, rock glaciers, glaciofluvial deposits, and a variety of moraines; briefly described by MacKevett (1970a; 970c, p. 24, 25; 1971, p. 27, 28; 1974). Many deposits are glacier related and (or) reflect the region's rigorous climate. Alluvium and older alluvium widespread along the streams and rivers; alluvium most conspicuous as ephemeral bars along flood plains of major rivers, such as the Nizina and Chitina; older alluvium commonly forms terraces that flank the rivers and larger streams. Colluvium slope wash, and similar deposits constitute thin veneers on many hillsides. Talus is well developed on some steep bedrock slopes, typically forms thin elongate cones whose lower extents coalesce into talus prons. Most landslides localized below abrupt topographic breaks, forming irregular masses characterized by hummocky surfaces and chaotic assemblages of angular and subangular blocks. Both inactive and active rock glaciers are exceptionally well developed in the quadrangle; they form sinuous or lobate, mainly elongate masses that head in cirques; many of the most spectacular rock glaciers are composed of fragmented, silica-rich Tertiary hypabyssal rocks. The glaciofluvial deposits include glaciolacustrine deposits, some glacial outwash, and a few kames and eskers. Glaciolacustrine deposits formed in a large periglacial lake that covered much of the Chitina Valley and Copper River Lowland during the last major laciation mantle most of the Chitina Valley and valleys of rivers and larger streams tributary to the hitina River. Ferrians (1963) describes glaciolacustrine deposits of the Copper River Basin part of he lake, and cites radiocarbon data indicating their age ranges between at least 38,000 years B.P. (before present) and 9,400±300 years B.P. Glacial outwash widely dispersed over flood plains of river that emanate from large valley glaciers; kames and eskers locally developed in the Chitina Valley; lateral medial, end, and ground moraines widely, and in places, strikingly, developed. Many deposits merge and are partly contemporaneous; many represent products of deposition that recurred intermittently throughout the Quaternary history of the region; several types of surficial deposits are still actively forming n general, the glaciofluyial deposits are among the oldest of the surficial deposits. Surficial deposits similar to those in the McCarthy quadrangle are widespread in nearby parts of Alaska and Canada; deposits in the Nabesna quadrangle have been mapped and described in some detail by Richter (1975)

SOUTH OF THE BORDER RANGES FAULT

VALDEZ GROUP (Cretaceous and Jurassic?) -- Originally named Valdes Series by Schrader (1900); revised to Valdez Group by Grant and Higgens (1910, p. 11) on the basis of their work in the Gulf of Alaska region. Domimant rock unit in southwestern part of quadrangle south of Border Ranges fault (MacKevett and Plafker, 974), which marks the northern boundary of the Valdez; base and top unexposed. Cut by Tertiary plutons thin- to medium-bedded metamorphosed flysch at least several thousand metres thick that consists of inter layered metagraywacke and argillite and minor schist, slate, and phyllite; metamorphosed to chlorite- or piotite-grade greenschist facies metamorphic mineral assemblages; mainly marked by steep northwest-striking foliation and by northwest-striking lineaments. Probably represents turbidite deposits that formed extensive deep sea fans. Valdez Group and similar rocks occupy an arcuate belt that extends at least from the western St. Elias Mountains, throughout the Chugach Mountains, westward to the Shumagin Islands. The only diagnostic megafossils from this belt tabulated by Jones and Clark (1973, p. 135, 136) indicate a ate Cretaceous (Maestrichtian) age. No definitive age data from Valdez rocks in the McCarthy quadrangle y inference, the Valdez here is probably also Late Cretaceous, but possibly includes some older rocks; may be partly correlative with other Cretaceous turbidites, such as the Yakutat Group (George Plafker, oral commun., 1975) of the eastern Gulf of Alaska region and the Sitka Graywacke of insular southeastern

METAMORPHIC ROCKS

INTRUSIVE ROCKS--Granodiorite and tonalite with subordinate hypabyssal rocks. Forms elongate plutons in

Alaska (Loney and others, 1963)

southwestern part of quadrangle south of the Border Ranges fault; emplaced in Valdez Group along broadly concordant contacts. Characteristically foliated and, in places, cataclastic. Generally medium-grained, hypidiomorphic-granular granodiorite and tonalite with fairly abundant accessory hornblende. The hypabyssal varieties commonly form late-stage dikes and sills, are chiefly dacite; interpreted as product of partial melting of deeply buried Valdez Group flysch. Similar rocks are known from the Bering Glacier quadrangle (Hudson and others, 1976, in press) and westward along the northern flank of the Chugach Mountains south of the Border Ranges fault. Not radiometrially dated in McCarthy quadrangle; a dacitic phase of inferred correlative pluton in the Anchorage quadrangle yielded a K-Ar age on hornblende of 33.9<u>+</u>2 m.y. (Berry and others, 1976, p. 2)

BETWEEN BORDER RANGES FAULT AND TOTSCHUNDA FAULT SYSTEM SEDIMENTARY, VOLCANIC, AND METAMORPHIC ROCKS

WRANGELL LAVA (Quaternary and Tertiary) -- Part of an extensive calc-alkaline volcanic province that dominates upland regions of the Wrangell Mountains and is widespread in the less mountainous northeastern part of he quadrangle; for map and descriptive purposes, Tertiary tillite and the Frederika Formation (MacKevet 1970a) are included with the Wrangell Lava (Mendenhall, 1905, p. 57-62) in this report. The Wrangell Lava consists of abundant flows and tephra and local sedimentary rocks; constituted mainly of effusive products of shield or composite stratovolcanoes or their satellitic eruptive centers. Wrangell Lava, including the Frederika, lies unconformably on Cretaceous or older rocks; shallow-seated intrusive rocks (described separately) genetically related to Wrangell Lava volcanism cut parts of the volcanic sequence. The Lava is at least 2,000 m thick and thin bedded to massive. The flows range from basalt to rhyolite, but are mainly andesite with less abundant dacite; the pyroclastic rocks, which range from

> agglomerate to ash, are dominantly lithic and crystal tuff; Wrangell Lava contains local tillite, gravel, and conglomerate and mudflows that may represent lahars. The flows have broad textural variations including vitrophyres and agglutinates, but they are dominantly porphyritic rocks with fine-grained intersertal groundmasses. The Frederika Formation (MacKevett, 1970a; 1971, p. 21-23) formed in local intermontane basins prior to and during early stages of Wrangell Lava volcanism; locally distribute best exposed in Tps. 2 and 3S., Rs. 16, 17, and 18 E. The Frederika is as much as 650 m thick and documents continental sedimentation, being constituted mainly of diverse conglomerates and sandstones with lesser amounts of siltstone, shale, impure limestone, and lignite. Fossil leaves from the Frederika indicate a Miocene age (MacKevett, 1971, p. 23, 32). Diamictitic tillite is best exposed near the White River in T. 1 S., Rs. 19, 20 E., where it consists of several moderate- to steep-dipping tillite successions interlayered with gravel and Wrangell Lava (Capps, 1916, p. 63-67; Denton and Armstrong, 1969); individual tillite sequences are as much as 70 m thick. Radiometric (potassium-argon) dates indicate that these tillites were deposited between 2.7 and 10 million years ago (Denton and Armstrong, 1969,

Wrangell Lava volcanism probably resulted from northward oblique underthrusting of the Pacific plate beneath the continent; older parts of Wrangell Lava at least 10 m.y. old (Richter, 1975); the youngest radiometrically dated Wrangell Lava in the quadrangle, the White River ash of local usage, is 1400-1500 years old (Stuiver and others, 1964). Wrangell Lava volcanism is still locally active at Mount Wrangell a few kilometres northwest of the quadrangle. Wrangell Lava is coextensive with its counterparts in the Probable correlatives of the Wrangell Lava occur in the Talkeetna Mountains, the Alaska Peninsula and Aleutian Islands; correlatives of the Wrangell Lava and the Frederika Formation occur discontinuously

PREDOMINANTLY UPPER CRETACEOUS SEDIMENTARY ROCKS--Upper Cretaceous sedimentary rocks that are parts of the Matanuska-Wrangell terrane (Berg and others, 1972, p. D17) and that locally include a few lower Cretaceou strata were subdivided into the Moonshine Creek, Schulze, Chititu, and MacColl Ridge Formations by Jones and MacKeyett (1969); widely distributed along southern flank of the Wrangell Mountains and in Chitina Valley; disconformably overlie Kennicott Formation or unconformably overlie pre-Cretaceous rocks; unconformably overlain by Tertiary rocks and cut by Tertiary plutons; where observed, interformational contacts are disconformities; estimated maximum thicknesses of individual formations: Moonshine Creek, 1,100 m; chulze, 75 m; Chititu, 1,700 m; MacColl Ridge, 770 m; thin to thick bedded. Lithologies: Moonshine Creek, siltstone and sandstone with minor conglomerate; Schulze, porcellanite with minor sandstone and conglomerate; Chititu, mudstone and shale, subordinate porcellanite, sandstone, and impure limestone; MacColl Ridge, coarse sandstone, minor granule and pebble conglomerate; the Upper Cretaceous sedimentary rocks formed at shallow to moderate depths in local basins in marginal seas; parts of the Moonshine Creek, Schulze, and Chititu are coeval. Abundant fossils indicate an age span from late Albian to Maestrichtian; ate Albian fossils are restricted to a few basal strata; and because the sequence is predominantly post Albian, the entire sequence is designated as predominantly Upper Cretaceous; paleontologic and other relevant data given in Jones and MacKevett (1969) and MacKevett (1970c, p. 19-23; 1971, p. 19-21, 32; 1974). Correlates with part of the Matanuska Formation in the Talkeetna Mountains and Matanuska Valley (Grantz, 1964) and probably with some other rocks in western parts of the Matanuska geosyncline (Payne,

LOWER CRETACEOUS SEDIMENTARY ROCKS--The quadrangle's Lower Cretaceous sedimentary rocks of the informally

designated Matanuska-Wrangell terrane (Berg and others, 1972, p. D17) consist of unnamed Neocomian rocks

and the Albian Kennicott Formation as defined by Jones and MacKevett (1969, p. K7). Neocomian rocks are most abundant in western parts of the quadrangle and occur locally south of Chitina River in the southcentral part of the quadrangle; the Kennicott occurs widely, but not extensively, throughout the southern parts of the quadrangle. Lower Cretaceous sedimentary rocks are separated from Jurassic or older rocks by a marked angular unconformity, and locally nonconformably overlie Jurassic granitic rocks; they are overlain disconformably by Upper Cretaceous rocks or unconformably by Tertiary rocks. Contacts between Neocomian and Albian rocks are disconformities or slightly angular unconformities. The Lower Cretaceous sedimentary rocks are cut by a few Tertiary plutons; their maximum aggregate thickness is about 450 m; thin to medium bedded. Neocomian and Albian successions are marked by basal conglomerate; the Neocomian contains sandstone, shale, and, in western parts of the quadrangle, abundant impure bioclastic limestone consisting largely of fragmented <u>Inoceramus</u>. The Kennicott consists of sandstone, siltsone, and minor basal and intraformational conglomerate, shale, and limy concretions; the Lower Cretaceous sedimentary rocks mainly reflect nearshore, high-energy deposition in a transgressive marginal sea. Fossils from the Neocomian rocks indicate Hauterivian and Barremian Stages of the Early Cretaceous (Grantz and others, 1966, p. C46). The Kennicott Formation can be subdivided into two well-defined early Albian faunal zone based on the ammonites Moffitites robustus and Brewericeras hulenense (Jones and MacKevett, 1969, p. K10 K11). Correlatives of the Lower Cretaceous sedimentary rocks occur widely throughout Payne's (1955) extensive Matanuska geosyncline; best represented by Nelchina Limestone and associated rocks (Grantz and others, 1966, p. C46) and lowermost parts of Grantz's revised Matanuska Formation in the Talkeetna Mountains and nearby regions (1964, p. IIO), and by Neocomian rocks near the mouth of the Chitina River (Grantz and others, 1966, p. C46); older (pre-Hauterivian) Neocomian parts of the Lower Cretaceous sequence were not recognized in the quadrangle, but occur at scattered localities to the west, south, and east (Grantz and others, 1966, p. C46; D. L. Jones, oral commun., 1974; Sharp and Rigsby, 1956, p. 118, 119) UNDIVIDED JURASSIC MARINE SEDIMENTARY ROCKS--Represents lower part of Matanuska-Wrangell terrane of Berg and

others (1972, p. DI7); subdivided into three formations, Lubbe Creek, Nizina Mountain, and Root Glacier. by MacKeyett (1969, p. A35-A49); confined to south-central part of Wrangell Mountains, mainly Tps. 3 and 4 S., Rs. 13, 14, 15, and 16 E. Gradationally overlies the upper member of the McCarthy Formation and unconformably overlain by post-Jurrassic rocks; marked by interformational disconformities and local intraformational hiatuses; locally cut by Tertiary plutons; the sequence is more than 1,600 m in combined thickness; maximum thicknesses for the individual formations are: Lubbe Creek, 90 m; Nizina Mountain, 420 m; Root Glacier, 1,200 m; thin to medium bedded. Lithologies range from spiculite and minor coquing (Lubbe Creek), upward through graywacke (Nizina Mountain), to mudstone, siltstone, and subordinate sandstone, shale, and conglomerate (Root Glacier); largely products of intermittent, fairly rapid, sedimentaion in a subsiding basin under shallow marine, locally littoral, conditions. Abundant fossils substantiate an age span of Early Jurassic (Pliensbachian Stage) to Late Jurassic (Kimmeridgian Stage); faunal data given in MacKevett (1969, p. A42, A45, A48, A49; 1971, p. 29-32); the undivided Jurassic marine sedimentary rocks broadly correlate with sparsely distributed Jurassic rocks in the Valdez quadrangle (Grantz and others, 1966, p. C40, C44), with similar rocks in the Talkeetna Mountains described by Grantz (1960a, b), and with some other Jurassic rocks in southern Alaska discussed by Imlay and Detterman (1973)

KOTSINA CONGLOMERATE (Upper or Middle Jurassic)--Named by Rohn (1900, p. 431). Restricted to western part of quadrangle (Tps. 2 and 3 S., R. 8 E.); unconformably overlies lower member of McCarthy Formation; top unexposed; cut by a few Upper Jurassic dikes; at least 500 m in maximum thickness; thin to thick bedded. Mainly well indurated conglomerate with locally derived pebbles and cobbles; subordinate sandstone and shale; mainly reflects rapid local marine deposition in response to orogenesis. No diagnostic fossi found in the Kotsina. Isotopic age determinations (Grantz and others, 1966, p. C43, C44) indicate a minimum age of Late Jurassic and suggest a Middle or Late Jurassic age for the Kotsina Conglomerate. The Kotsina extends westward into the northeastern part of the Valdez quadrangle; conglomeratic Jurassic

rocks that are probable correlatives are known in the Talkeetna Mountains and elsewhere in southern Alaska (Imlay and Detterman, 1973, p. 10, 11) McCARTHY FORMATION (Lower Jurassic and Upper Triassic)--Originally named McCarthy Creek Shales by Rohn (1900, p. 426); after several revisions in nomenclature, MacKevett (1963) divided the McCarthy Formation into a lower and an upper member

several other Alaskan localities (Martin, 1916, p. 686-718)

Upper member -- Confined to south-central flank of Wrangell Mountains, mainly Tps. 3 and 4 S., Rs. 14, 15, and 16 E.; slightly more than 600 m in maximum thickness. Grades downward into the lower member and upward into the Lower Jurassic Lubbe Creek Formation; where the Lubbe Creek is absent, overlain disconormably by Middle or Upper Jurassic rocks, or unconformably by Cretaceous rocks; dominantly thin bedded. Consists of very fine grained spiculite, impure chert, impure limestone, and shale; mainly formed at variable depths in a restricted sea where siliceous organisms flourished. Paleontologic evidence (cited in MacKevett, 1970a, b; 1971, p. 15, 29) documents Early Jurassic ages that range from Hettangian to Pliensbachian Stages; possibly the unfossiliferous lowermost parts of the member are as old as latest Triassic. No known correlatives in nearby regions, but parts of the Talkeetna Formation in the Talkeetna Mountains (west of the quadrangle) are temporal but not lithologic equivalents Lower member--Occurs widely along southern flank of Wrangell Mountains and, locally, near headwaters of Chitina River; as much as 300 m thick; in gradational contact with underlying Nizina Limestone and overlying upper member; locally unconformably overlain by Kotsina Conglomerate (Jurassic) or by Cretaceous rocks; at a few places cut by plutons of Chitina Valley batholith or by Tertiary dikes and sills; characteristically thin bedded. Incompetent and readily susceptible to folding; forms subdued outcrops. Locally laterally grades with upper part of Nizina Limestone. Consists of impure limestone (mainly wackestone in the terminology of Dunham, 1962), calcareous carbonaceous shale, and impure, locally spiculitic, chert; formed in marine, partly starved basin, environments. Fossils from the lower member indicate the Norian, mainly late Norian, Stage of the Late Triassic; diagnostic fossils are restricted to the lower part of the member, thus its upper part may include some post-Norian riassic and Lower Jurassic rocks; characteristic lower member fossils are pelecypods of the genus Monotis; paleontologic data for the lower member are given in Moffit (1938, p. 61, 62) and MacKevett (1971, p. 29; 1972). Probable correlatives of the lower member include Monotis-bearing Upper Triassic rocks in the Nabesna quadrangle (Richter, 1975), the Yukon Territory (Muller, 1967, p. 50), and at

CHITISTONE AND NIZINA LIMESTONES (Upper Triassic)--Rohn (1900, p. 425) originally applied the name Chitistone Limestone to carbonate rocks that overlie the Nikolai Greenstone; subsequently, Martin (1916, p. 693) termed the upper, generally thinner bedded and darker parts of Rohn's Chitistone, the Nizina Limestone. a usage that persists. The Chitistone and Nizina Limestones are abundant along the southern flank of the Wrangell Mountains, mainly in central and western parts of the quadrangle, sparse in the northeastern part; maximum aggregate thickness of the two formations is about 1,100 m; both formations characterized y marked lateral changes in thickness, many Chitistone-Nizina sections thinner than a few hundred metres. Stratigraphic and petrographic details of the Chitistone and Nizina are best described by Armstrong, MacKevett, and Silberling (1970, p. D49-D62); Chitistone and Nizina Limestones both are cut by a few Jurassic and Tertiary plutons. The Chitistone disconformably overlies the Nikolai Greenstone and grades upward into the Nizina; its maximum thickness is about 600 m; the Chitistone characteristically contains trata between 0.5 and 7 m thick that are excellent cliff formers and locally brecciated or cavernous. he lowermost 105 m of the Chitistone contain abundant dolomite, algal mat chips, stromatolites, relicts of evaporites, and other features indicative of intertidal-supratidal conditions and local sabkha environments. The upper part consists of diverse limestones, including lime mudstone, wackestone, packstone, and grainstone (Dunham's 1962, p. 117, classification) and minor chert nodules, indicating deposition in neritic environments; some Chitistone and Nizina rocks emit fetid odors when freshly broken. The Nizina Limestone is about 500 m in maximum thickness; its upper parts are lithologically gradational with parts of the overlying McCarthy Formation. The Nizina consists of diverse limestones that generally contain subordinate chert as nodules, lenses, and coalescing masses; its upper strata contain small components of noncarbonate detritus. The Nizina formed in a neritic environment, generally under deeper water than chitistone. Diagnostic fossils rare in the Chitistone; the Chitistone's age, Karnian Stage of the Late Triassic, is mainly documented by ammonites of the genus <u>Tropites</u>. Nizina fossils, mainly ammonites and pelecypods, indicate a Late Triassic age span from late Karnian to middle Norian. Paleontological data for the Chitistone and Nizina Limestones are given by Armstrong, MacKevett, and Silberling (1970, p. D57-D60), Moffit (1938, p. 50-57), MacKevett (1970c, p. 15; 1971, p. 28). The Chitistone and Nizina are probable correlatives of other Triassic carbonate rocks that occur sparsely in the Nabesna quadrangle (Richter, 1975) and in central Alaska (Smith and Lanphere, 1971, p. 17); probably correlate with parts of the Mush Lake Group in the Yukon Territory (Muller, 1967, p. 47, 50; Read and Monger, 1975, p. 55, 58) and possibly with some other Upper Triassic limestones elsewhere in Alaska

MARBLE--Contact-metamorphosed Chitistone and Nizina Limestones occur in south-central part of quadrangle south of the Chitina River and, locally, extend southeastward into the Bering Glacier quadrangle; as a few small undifferentiated masses within unit Ten east of the Kuskulana River; localized near granitic plutons of the Chitina Valley batholith and formed by metamorphic processes related to the plutonism. Typically fine- to medium-grained calcite-rich marble, locally dolomitic; in places, crudely schistose or banded; contains a few relicts of nodular chert and stylolites

NIKOLAI GREENSTONE (Upper and(or) Middle Triassic) -- Named by Rohn (1900, p. 425) for extensive, mainly altered tholeiitic basalt sequence that occurs widely in the quadrangle; at least 3,000 m in aggregate thickness Generally unconformably overlies the Skolai Group; locally in northeastern part of quadrangle conformably overlies Middle Triassic <u>Daonella</u> beds; overlain disconformably by Chitistone Limestone (Late Triassic) or unconformably by younger rocks. Cut by Triassic gabbro dikes and sills that are interpreted as feeders for the Nikolai, granitic rocks of the Klein Creek pluton and Chitina Valley batholith, and by epizonal Tertiary plutons. Largely subaerial; locally submarine in northeastern part of quadrangle, T. 3 S.,

Rs. 23 and 24 E. and T. 2 N., R. 24 E., where basal sections of the Nikolai contain pillow basalt and intercalated argillite. Elsewhere base of the Nikolai generally characterized by volcanic conglomerate as much as 70 m thick; dominantly intermixed pahoehoe and aa with individual flows between 15 cm and 15 m thick; some brecciated flow tops. Except for interior zones of thicker flows, characteristically amygdaloidal; typically altered and locally metamorphosed to prehnite-pumpellyite facies assemblages. Alteration effects, though widespread, rarely are sufficiently intense or pervasive to mask primary minerals and textures; consequently the term "greenstone" is a misnomer for most rocks in the Nikolai Dominantly slightly porphyritic tholeiitic basalt with medium-grained plagioclase (labradorite) and less abundant clinopyroxene phenocrysts in fine-grained intergranular groundmasses rich in plagioclase and clinopyroxene. Contains some iron and titanium oxides, serpentinized olivine relicts, and an array of secondary minerals, chiefly chlorite and epidote. Amygdules constituted mainly of calcite and chlorite or quartz and epidote; some contain zeolites, prehnite, or native copper. More detailed petrographic descriptions given by Moffit (1938, p. 37-42) and MacKevett (1970c, p. 11, 12; 1971, p. 8-10). Mean copper content of 140 Nikolai basalt samples 157 ppm (parts per million) (MacKevett and Richter 174, p. 14). Stratigraphically bracketed by fossiliferous strata that contain diagnostic Middle Triassic (Ladinian) pelecypods and Late Triassic (Karnian) ammonites; therefore late Middle and (or) early Late Triassic in age. Interpreted as part of a vast lava field that covered broad tracts of south-central Alaska and adjacent parts of Canada. The Nikolai is well exposed in the Nabesna quadrangle (Richter, 1975); its correlatives, termed Amphitheatre Basalt by Rose (1966, p. 8, 9), extend northwestward along the southern flank of the Alaska Range at least to the upper reaches of the Susitna River (Smith and Lanphere, 1971, p. 17); Nikolai lavas constitute much of the Mush Lake Group in the Kluane Lake map area, Yukon Territory (Muller, 1967, p. 47-54). Nikolai Greenstone occurs sparingly in the northeastern Bering Glacier quadrangle and contiguous parts of Canada and probably extends southeastward into insular south-eastern Alaska (George Plafker, oral commun., 1975)

SKOLAI GROUP (Smith and MacKevett, 1970, p. Q3)--Name applied to a greater than 2,500 m thick, generally slightly metamorphosed, predominantly volcaniclastic and volcanic sequence in McCarthy B-4 and C-4 quadrangles. Essentially correlative with the revised Mankomen Group of Richter and Dutro (1975) and Tetelno Volcanics in the eastern Alaska Range and with similar rocks that are widespread in south-central Alaska and the Yukon Territory. Forms part of a terrane that has been interpreted as vestiges of a late Paleooic island arc (Richter and Jones, 1973b; Bond, 1973) and constitutes the regional basement for much of eastern south-central Alaska between the Denali and Border Ranges faults; the volcanic arc probably formed directly on oceanic crust; subdivided into Hasen Creek and underlying Station Creek Formations by Smith and MacKevett (1970); volcanic and volcaniclastic rocks of the Station Creek Formation represent the submarine magmatic arc and its derivative rocks. Sedimentary rocks of the Hasen Creek Formation

mainly indicate nonvolcanigenic marine deposition along and near the fringes of the arc HASEN CREEK FORMATION (Lower Permian) (Smith and MacKevett, 1970, p. Q16, 17)--Widely occurring marine sedimentary rocks; as much as 600 m thick in northeastern part of quadrangle, typically less than 200 m thick elsewhere. Conformably overlies Station Creek Formation; mainly overlain by Nikolai Greenstone with slight angular unconformity; locally, in northeastern part of quadrangle, overlain by thin remnants of Middle Triassic Daonella-bearing siltstone and shale, which is included in the Hasen Creek for map and descriptive purposes. Cut by dikes and sills of Triassic gabbro, and, in a few places, by Jurassic or Tertiary intrusive rocks. Consists of argillite, shale, sandstone, chert, limestone, and minor conglomerate; locally thermally metamorphosed where near Jurassic plutons; largely of nonvolcanic derivation; except for some limestone, mainly thin bedded

imestone of Hasen Creek Formation--Includes Golden Horn Limestone Lentil (Smith and MacKevett, 1970, p. Q20-Q25) and other lenticular limestone masses large enough for cartographic representation; winly confined to upper part of formation; as much as 250 m thick; ranges from thin to thick

The Hasen Creek, particularly its limestone, is highly fossiliferous and contains diverse corals crinoids, brachiopods, bryozoa, and fusulinids; extensive faunal lists are given by Moffit (1938, Holfcampian) age, a few collections indicate ages as young as early Guadalupian (Early Permian (MacKevett, 1970c, p. 10). The Hasen Creek Formation correlates with the Eagle Creek Formation of the Mankomen Group in the eastern Alaska Range (Richter and Dutro, 1975, p. B10-B18) including the Nabesna quadrangle (Richter, 1975). Also correlates with younger parts of the Cache Creek Group and similar rocks in the Yukon Territory (Muller, 1967, p. 37-43; Read and Monger, 1975, p. 55-59)

STATION CREEK FORMATION (Lower Permian and Pennsylvanian) (Smith and MacKevett, 1970, p. Q6)--Informally divided into a volcaniclastic member and volcanic flow member separated by gradational contact. members of submarine origin. Conformably underlies Hasen Creek Formation; in T. 5 S., Rs. 10, 11 and 12 E., structurally overlies upper Paleozoic gabbro and orthogneiss along poorly exposed, probably conformable, contacts; in upper valley of Canyon Creek Glacier conformably overlies upper Paleozoic gabbro; basal parts of formation not recognized elsewhere; cut by upper Paleozoic monzonitic-granitic complex, Triassic gabbro, and younger intrusive rocks; volcaniclastic member as much as 800 m thick. Volcanic flow member about 1,200 m in maximum exposed thickness; the volcaniclastic member ranges from thin bedded to massive; its lithology reflects an upward transition from coarse volcanic breccia in lower part of the member, through abundant volcanic graywacke, to volcanilutite. Most rocks of both members weakly metamorphosed to prehnite-pumpellyite metamorphic grades; locally albitized flows in volcanic flow member are between 3 and 60 m thick, locally pillowed and brecciated; flow member consists of altered lavas, mainly andesites and basalts, and minor intercalated volcaniclasti rocks; analytical data for the Station Creek given in Smith and MacKevett (1970, p. Q12); no fossils found in either member. The volcaniclastic member is broadly correlative stratigraphically and lithologically with the Middle Pennsylvanian to Early Permian Slana Spur Formation of the Mankomen Group Richter and Dutro, 1975, p. B4-B10, B20) in the eastern Alaska Range and with parts of the Cache Creek Group in the Yukon Territory (Muller, 1967, p. 33-43). The volcanic flow member correlates with the Pennsylvanian part of the Tetelna Volcanics in the Nabesna quadrangle and nearby parts of the eastern Alaska Range (Richter, 1975).

METAMORPHOSED SKOLAI GROUP (Lower Permian and Pennsylvanian)--Extensive in southern part of quadrangle north of Border Ranges fault where it constitutes part of the basement terrane. Locally apparen conformably overlies gabbro along poorly exposed contacts; elsewhere base not exposed. Consists of greenschist to amphibolite facies metamorphic rocks that apparently grade northward into weakly metamorphosed rocks typical of the Skolai Group; locally unconformably overlain by Mesozoic rocks fault bounded along southern margin. A few small tectonically emplaced serpentinized ultramafic masses within the metamorphosed Skolai terrane. Cut by plutons of monzonitic-granitic complex Chitina Valley batholith, and local Tertiary rocks; thickness undeterminable; complexly folded on all scales, with local granulation and slip cleavage; mainly schist, phyllite, amphibolite, and marble described below; corresponds to Strelna Formation which was assigned a Mississippian age by Moffit and Mertie (1923, p. 21-28) on the basis of erroneously interpreted paleontologic evidence Subsequent studies of the critical fossil collections and of additional collections from marble in the Strelna document an Early Permian age. Coeval with less metamorphosed Skolai Group whose probable age ranges from Middle Pennsylvanian to Early Permian; also represents metamorphosed correlatives of parts of the revised Mankomen Group and Tetelna Volcanics of the eastern Alaska Range (Richter and Dutro, 1975) and Cache Creek Group in the Yukon Territory (Muller, 1967, p. 33-44): inferred correlatives extend southeastward into the Bering Glacier quadrangle and nearby parts of Canada, and westward, north of, but proximal to, the Border Ranges fault

Marble of metamorphosed Skolai Group--A widely distributed component of the structurally complex metamorphosed Skolai Group in southern part of quadrangle. Forms elongate masses as much as 300 m thick; mainly fine- to medium grained, banded impure marble; locally deformed. Generally contains moderately abundant silicate minerals that indicate greenshist, greenshist-amphibolite ansition, or, rarely, amphibolite metamorphic facies. Locally yields poorly preserved Early Permian fossils; interpreted as temporal equivalents of limestone of Hasen Creek Formation (P1); possibly includes some Upper Pennsylvanian rocks

KASKAWULSH GROUP OF KINDLE (1953)--A metamorphosed marine sequence, mainly of marble, probably a few thousand metres thick, in the eastern part of the quadrangle; base unexposed. Coextensive with widely occurring similar rocks in Yukon Territory described and named by Canadian geologists. Represents west ernmost known extent of Alexander terrane of Berg and others (1972). Generally multiply folded; mainly thick bedded. In fault contact with monzonitic-granitic complex, Skolai Group, and Triassic sedimentar rocks; unconformably overlain by Wrangell Lava and, rarely, by Upper Cretaceous sedimentary rocks; cut by compositionally diverse, mainly mafic, dikes. Volumetrically about two-thirds fine- to coarse-grained marble, one-third schist, phyllite, and minor amphibolite. The marbles are locally schistose, banded, or granulated and range from rocks that consist almost entirely of calcite to calcite-dominant multimineral assemblages. Most other rocks are strongly schistose with locally developed kink banding and slip cleavage; greenschist, greenschist-amphibolate transition, and, rarely, amphibolite facies metamorphic mineral assemblages. The only fossils found in Kaskawulsh in the quadrangle are poorly preserved tabulate horn corals that suggest a Devonian age; numerous Devonian fossil collections from Kaskawulsh Canada (Read and Monger, 1975, p. 55) document Ordovician, Devonian, and probable Mississippian fossils The Kaskawulsh and its counterparts in Yukon Territory are the lower parts of the extensive Alexander terrane, whose maximum age in southeastern Alaska is Ordovician or older (Berg and others, 1972, p. D2)

INTRUSIVE ROCKS In addition to intrusive rocks shown on the map and described herein, the quadrangle contains numerous com positionally diverse dikes and sills not shown on the map. Such rocks, to a large extent, reflect the main igneous episodes. Plutonic rocks are classified according to the system recommended by the IUGS (International Union of Geological Sciences) subcommission on the systematics of igneous rocks, A. L. Streckeisen,

HYPABYSSAL ROCKS--Widely distributed in quadrangle north of the Chugach front, but best developed throughout a northwest-trending belt along the southern flank of the Wrangell Mountains; forms dikes, sills and small, mainly concordant stocks; intrudes rocks as young as lower (Miocene) part of Wrangell Law but most abundant cutting Upper Cretaceous sedimentary rocks. Dominantly dacite, andesite, and rhyodacite porphyry; typically strongly porphyritic with plagioclase and less abundant quartz or sanidine phenocrysts in strongly altered very fine grained felty groundmasses. Mafic minerals mainly represented by relicts of biotite and hornblende; briefly described by MacKevett (1970a; 1970c, p. 27, 28; 1971, p. 24, 25; 1972; 1974). Interpreted as subvolcanic hypabyssal phases of Wrangell Lava; probably formed during much of the time span of Wrangell volcanism. Two samples dated by K-Ar method on biotite and anidine respectively yielded ages of 3.8±0.8 m.y. and 6.5±0.2 m.y. (J. von Essen, unpub. data, 1972 M. L. Silberman, unpub. data, 1975). Correlates with the younger porphyry of the Nabesna quadrangle (Richter, 1975) and with hypabyssal rocks associated with Wrangell Lava in nearby parts of Alaska and Canada (Muller, 1967, p. 89, 90; Souther and Stanciu, 1975)

GRANODIORITE--Granodiorite and related rocks that are locally exposed along southern flank of Wrangell Mountains; forms small, mainly discordant, stocks that cut diverse rocks including Skolai Group, monzonitic-granitic complex. Nikolai Greenstone, Cretaceous sedimentary rocks, and, locally, lower part of Wrangell Lava. Narrow, weakly thermally metamorphosed aureoles developed in some contiguous hos rocks; locally contains inclusions of host rocks. Typically nonfoliate, fine-medium-grained, hypidio morphic granular rocks. Intrusive masses consist of granodiorite with subordinate granite and local dioritic or gabbroic border zones; biotite is the dominant accessory in felsic phases and hornblende in mafic phases Additional descriptions given in MacKeyett (1970c p. 26, 27, 1972, 1974). Inter preted as subvolcanic plutonic phases of Wrangell volcanism. Sample of granodiorite dated by K-Ar method has concordant ages of 8.4+0.25 m.y. on biotite and hornblende (MacKevett, 1970c, p. 27). Cor relative rocks probably occur in and near the provenance of the Wrangell Lava beyond the limits of the quadrangle; none have been reported except for an occurrence in the Yukon Territory (Read, 1976, in

CHITINA VALLEY BATHOLITH--Named here for large plutonic masses along northern flank of Chugach Mountains contiguous to Chitina Valley. Crops out locally throughout Chitina Valley and in western part of quadrangle, both north and south of the valley, but north of the Border Ranges fault. Cuts Triassic and older rocks of Taku-Skolai terrane, mainly Skolai Group; the intrusive contacts are broadly concordant, but are in many places discordant; uncommonly nonconformably overlain by Cretaceous sedimentary rocks or by Wrangell Lava. Metamorphic aureoles generally developed in adjacent country rock. Typically strongly foliated; compositionally diverse, ranging from granite to quartz diorite, but dominantly tonalite and granodiorite; generally contains fairly abundant accessory hornblende and biotite. N known volcanic equivalents; coextensive with batholithic rocks in the Bering Glacier quadrangle (Hudson and others, 1976, in press) that extend southeastward into Canada; also correlates with some granitic rocks in eastern parts of the Valdez quadrangle; radiometric dates, mainly on hornblende, indicate an age range between 138 and 146+4 m.y. (Late Jurassic) (J. G. Smith, unpub. data, 1973; M. L. Silberman, unpub. data, 1975). Synchronous with early stages of a major regional orogeny that began in the Late Jurassic, and may be related to subduction along the Border Ranges fault. The tenability of such a concent is constrained by the distribution of the batholith, including the proximity of some batholithic rocks to surface traces of the Border Ranges fault; the validity of the concept requires that large masses of continental crust of peripheral and nearby parts of the upper plate have been destroyed during

GABBRO--Small masses of gabbro that occur widely throughout the quadrangle north of the Border Ranges fault forms sills and dikes and a few small pluglike discordant plutons; most gabbro bodies are too small to show on the map. Characteristically cuts Skolai Group, particularly its Hasen Creek Formation; at a few places it cuts lower part of the Nikolai Greenstone. The gabbro differs from upper Paleozoic gabbro by not being layered or foliated and by being less altered and generally containing less abundant hornblende; typically medium to coarse grained and subophitic in texture; volumetrically it consists of about 90 percent plagioclase (labradorite) and clinopyroxene; descriptions given by MacKevett (1970a; 970c, p. 25, 26). The gabbro is interpreted as feeders and precursors of the extensive and voluminous Nikolai Greenstone lavas; the generation of the gabbro (and Nikolai) reflects a regimen of tensional tectonics and tapping of deep-seated magma. Essentially coeval with the Nikolai, late Middle and (or) early Late Triassic in age. Similar gabbros occur sporadically in northeastern parts of the Valdez quadrangle. Other correlative gabbros known from the Nabesna quadrangle (Richter, 1975) and from Yukon

MONZONITIC-GRANITIC COMPLEX--Originally briefly described by Overbeck (1918, p. 53-57); occurs widely in southeastern part of quadrangle. Intrudes lower part of Skolai Group and its metamorphosed equivalents mainly broadly discordant with invaded rocks. In Yukon Territory (R. B. Campbell, oral commun., 1975) and Bering Glacier quadrangle cuts Kaskawulsh Group; in the McCarthy quadrangle, exposed contacts between the complex and the Kaskawulsh are faults or probable faults. Cut by Jurassic and Tertiary granitic plutons; nonconformably overlain by Wrangell Lava and small remnants of Upper Cretaceous sedimentary rocks of Matanuska-Wrangell sequence. Mainly medium-grained equigranular granitic rocks with some fine or coarse-grained variants; typically unfoliated; locally porphyritic and, in a few places, cataclastic. Consists of massive, felsic granitic and monzonitic rocks with local mafic border facies; strongly differentiated and lithologically diverse. The bulk of the complex contains abundant granite and quartz monzonite and some quartz syenite, syenite, and monzonite; the border zone chiefly quartz monzodiorite, monzodiorite, and gabbro; most of the complex characterized by abundant K-feldspar and plagioclase (mainly sodic andesine), less abundant quartz, and a quantitatively minor array of accessory and secondary minerals. The tectonic significance and origin of the complex are conjectural. On a regional scale apparently cuts two grossly dissimilar structural terranes described by Berg, Jones, and Richter (1972): the Alexander terrane, represented by continental crust of the Kaskawulsh Group, and the Taku-Skolai terrane, which overlies oceanic crust; as these terranes were probably widely separated when the complex was emplaced, the complex probably evolved from a deep-seated magmatic source of great extent. Radiometric dates on hornblende from a monzonite and a quartz monzodiorite indicate ages of 295±8 m.y. and 297±9 m.v. respectively (J. G. Smith, unpub. data, 1973; M. L. Silberman, unpub. data, 1975); both dated samples were from near margins of the intrusive, and probably reflect early stages of crystallization. The complex extends into northeastern parts of the Bering Glacier quadrangle. Correlates with the Ahtell pluton of the eastern Alaska Range, which, according to Richter and others (1975, p. 824, 825), has a mafic border and a minimum K-Ar age (on biotite) of 285 m.y. (Pennsylvanian). Correlates

GABBRO AND ORTHOGNEISS--Includes a thick complex of interlayered gneiss and gabbro in Tps. 4, 5, and 6 S. Rs. 8, 9, 10, 11, and 12 E., and layered gabbro elsewhere in southern part of quadrangle; base unexposed Conformably overlain by Skolai Group or its metamorphosed equivalents; cut by a few plutons of Chiting Valley batholith. Interlayered gneiss and gabbro consist of quartz monzodiorite or monzonite gneiss and associated gabbro that contains minor dioritic phases. Contact relations between the layers are equivocal. Gabbros associated with the gneiss and the other gabbro in the quadrangle are layered hornblendeand (or) clinopyroxene-bearing rocks that generally are altered and foliated; they are fine to coarse grained and contain local pegmatitic facies. The gneiss represents an uncommon rock type that has affinities with plagioclase-bearing members of the charnockite series; contains in addition to plagioclase (generally sodic andesine), hypersthene, clinopyroxene, K-feldspar, and quartz; gabbroic parts of the unit are interpreted as part of upper Paleozoic (Pennsylvanian) oceanic crust that underlies the Skolai Group, but the significance and origin of the gneiss are conjectural; possibly the gneiss is related to the monzonitic-granitic complex. Radiometric dating (M. L. Silberman, unpub. data, 1975) on biotite from the gneiss indicates a minimum age of 271±11 m.y.; field relations with the Skolai Group indicate that the gabbro and orthogneiss is Pennsylvanian. Gabbro and orthogneiss extend westward into

with Muller's "Donjek Range intrusions" (1967, p. 72-79) in the St. Elias Mountains, Yukon Territory

parts of the Valdez quadrangle; similar rocks are not known elsewhere in the general region. ULTRAMAFIC ROCKS--Small serpentinized alpine-type ultramafic masses north of, but near, the Border Ranges fault; tectonically emplaced in metamorphosed Skolai Group; includes some partly serpentinized gabbro; intensely sheared. Consists largely of ferruginous serpentine minerals; lesser amounts of phlogopite, tremolite, magnetite, chromite, calcite, pyrrhotite, and a few relicts of olivine and pyroxene; probably originally peridotite and dunite. Some small anomalous concentrations of nickel and chromium. Interpreted as fragments of tectonically emplaced upper Paleozoic (Pennsylvanian) oceanic crust. Correlates with some ultramafic rocks west of the quadrangle that have similar geologic settings; these include peridotite masses at the Spirit Mountain prospect (Kingston and Miller, 1945; Herreid, 1970) and the Bernard (Red) Mountain ultramafic assemblage (Hoffman, 1974); probably also correlates with sparsely distributed ultramafic rocks that were emplaced in upper Paleozoic terranes in the Nabesna quadrangle (Richter, 1975) and in the Yukon Territory (Muller, 1967, p. 43-47)

FOLIO OF THE MC CARTHY QUADRANGLE, ALASKA

MAP MF-773 A MACKEVETT--GEOLOGIC MAP



NORTH OF TOTSCHUNDA FAULT SYSTEM

SEDIMENTARY AND VOLCANIC ROCKS WRANGELL LAVA (Quaternary and Tertiary)--See above

HISANA FORMATION (Lower Cretaceous)--Named by Richter and Jones (1973a) for marine and subaerial volcanic and volcaniclastic rocks that crop out northeast of the Totschunda fault (Richter and Matson, 1971); base not exposed. Unconformably overlain by Wrangell Lava; cut by granodiorite of Klein Creek pluton; at least 1,000 m thick; mainly thin and medium bedded. Consists of andesitic flows and diverse volcaniclastic rocks, including some volcanigenic sedimentary rocks. Formed during intermittent volcanic activity and sedimentation in shallow marine and subaerial environments; probably partly represents extrusive phases of Klein Creek and related mid-Cretaceous plutons in the Nabesna quadrangle. Widespread in the Nabesna quadrangle, the formation's type area, where it contains Early Cretaceous fossils (Richter,

MARINE SEDIMENTARY ROCKS (Cretaceous and Jurassic) -- Part of the informally designated Nutzotin Mountains sequence (Berg and others, 1972, p. D9); crops out near northeastern corner of quadrangle; base and top not exposed in quadrangle; cut by Klein Creek pluton; at least 1,250 m thick. Predominantly thin- to medium-bedded argillite and graywacke; metamorphosed to hornfels proximal to Klein Creek pluton; characteristically graded and rhythmically bedded. Represents turbidite deposits related to subsea fans that formed at shallow to moderate depths in a successor basin. Contains sparsely distributed pelecypods of the genus Buchia that indicate Late Jurassic age; the extensive and well developed Nutzotin Mountains sequence in the Nabesna quadrangle, its type area, ranges from Late Jurassic to Early Cretaceous (Richter, 1975). Correlates with parts of the Dezadeash Group in the Yukon Territory (Eisbacher, 1975; Muller, 1967, p. 54-59)

CHITISTONE AND NIZINA LIMESTONES (Upper Triassic)--See above NIKOLAI GREENSTONE (Upper and (or) Middle Triassic)--See above

HASEN CREEK FORMATION (Lower Permian) -- See above Limestone of Hasen Creek Formation--See above

STATION CREEK FORMATION (Lower Permian and Pennsylvanian)--See above

INTRUSIVE ROCKS

LEIN CREEK PLUTON (Richter, 1975)--Granitic rocks that crop out in northeast part of quadrangle northeast of Totschunda fault. Mainly discordant plutons that cut Chisana Formation, Nutzotin Mountains sequence, or Nikolai Greenstone. Nonconformably overlain by Wrangell Lava. Mainly forms composite stocks that re coextensive with or satellitic to the larger Klein Creek intrusive body in the Nabesna quadrangle some thermal metamorphic aureoles in invaded host rocks. Generally medium grained hypidiomorphic grant lar in texture and unfoliated; chiefly hornblende-biotite granodiorite and quartz monzonite with mafic border phases. Locally contains alteration assemblages and scattered sulfides indicative of porphyry opper type mineralization, features better developed in some Klein Creek rocks in the Nabesna quadrangle. Klein Creek intrusives may represent plutonic phases of igneous processes that produced the slightly older volcanics of the Chisana Formation. Radiometric dataing on biotite and hornblende from the Klein

others, 1975, p. 821). Locally extends into Yukon Territory near international boundary

Creek pluton in the Nabesna quadrangle indicates ages of lll±3.1 to 3.6 m.y. (Cretaceous) (Richter and

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